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HOW FIRES START IN MINES[1, 2]

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Of all the hazards faced by men engaged in mining, an underground fire inspires the greatest dread. For lengthy periods a mine fire holds the threat of imminent disaster, even when such a disaster does not occur.

No available figures give the total number of mine fires that occur annually in the United States, nor are there figures showing the cost of property damaged by such fires. If such figures were compiled, it is believed that they would be staggering, even to men well informed in mining.

The bureau's statistics on fires are limited to those that have led to loss of life and to disasters. These statistics show that over 25 men are killed annuall by mine fires or by explosions originating from fires in coal mines, and that from 1917 to 1926, 229 men were killed by fires in metal mines. Moreover, the Bureau of Mines has assisted at 69 fires in the past five years. The 69 fires include only those of a considerable magnitude and do not take into account the hundreds of small fires which are quickly extinguished and which in many mining districts are a common and almost daily occurrence.

For convenience and clearness, causes of fires in mines will be discussed under two general heads: First, foreign heat ignitions, and second, spontaneous ignitions. All fires caused by flames, heat, or electricity brought by men or appliances into the mine in the course of operation may be classified as foreign ignitions. Fires due to spontaneous combustion will be discussed in conjunction with spontaneous ignitions; the source of such combustion is not limited to the material originally in the mine, but applies as well to combustible material taken into the mine.

Foreign heat ignitions are brought about in numerous ways. The order in which these ignitions are discussed will be that of the frequency of their probable occurrence, although without complete statistics available the relative seriousness is subject to question.

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2 Presented at the regional meeting of the National Safety Council at Kansas City, Mo., April 25, 1928.

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In mines of all classes the open flames of miners' lamps, underground forges, and fires for thawing frozen air lines and water lines have been consistent agents in starting mine fires. Such flames have had the able assistance of gas feeders, accumulated trash, oily rags and waste, dry timbers or lagging, oil, and gasoline as the easily kindled media that supply heat to extend the fire into timbering and the material mined; the latter includes not only coal but also several combustible ores.

Fires of electrical origin now undoubtedly rank second in the list. Electric currents and electrical equipment of almost every type have been the cause of fires. The electric wired circuits, however, are probably the most frequent igniting agents.

Electric currents in a number of ways produce enough heat to ignite inflammable material. The first and most evident producer of heat is the electric arc, the flame of which has a very high heat intensity and is dangerous under some conditions of mining at almost any voltage and amperage. Arcs are produced at all "make-and-break" contacts in air. These "makes" and "breaks" may occur in the course of operating switches, commutators, trolley wheels, or controllers during normal duty; or they may be unintentionally produced by defective circuits, such as loose and poorly made connections, partial short circuits on exposed wires, or broken bonds on track. Arcing at bonds on mine haulage-tracks is frequently overlooked, especially when fine, as well as large-size, coal spilled from cars has accumulated about the bonds. Under such a condition a fire is almost inevitable, and is extremely difficult to control as there is usually a strong current of air in the haulageways.

Resistance to the passage of electricity through any conducting medium produces heat. Such heating can be closely compared to the heat of friction in ordinary mechanics. Under many conditions heating by passage of electric current can produce a temperature high enough to ignite any inflammable material that may be in contact with the electrical conductor. Insulation of circuits or machine windings on heavy overload may ignite from such heat, or fires may be started in inflammable material adjacent to overheated circuits or machines; fires may also be started by the passage of current through high-resistance material (such as canvas, posts, or timbers) in contact with electric circuits not normally overloaded. Ignition is more likely to take place when the material in contact with the circuit is damp.

Heat of resistance is used to produce the glowing filament of incandescent lamps, and there must be heat, otherwise there would not be light. Incandescent bulbs can and do light inflammable material if kept in contact long enough; hence the use of cardboard, paper, or other combustible as a shade for electric lamps should be discouraged, and electric light bulbs should not be allowed to touch timber caps, legs, or lagging.

Heat is produced in the normal use of resistors or "grids" in connection with speed control and starting equipment of electric motors. Grids have started fires when improperly installed and maintained. The surrounding surfaces should be well fireproofed in places where grids are used on stationary electrical equipment.

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Fires have been reported even in modern, underground storage-battery charging stations. This is serious, since hydrogen gas may be present to convert slight arcing into a fire of large proportions, or even to cause an explosion.

Lightning has been known to go underground on power circuits. There is no reason why fires can not be started in mine workings in the same way as in surface buildings, which frequently fire when struck by lightning; hence there should be provision against entrance of current from lightning into mine wiring.

Stray currents complete the list of electrical sources of fires. There is a record of a stray current which was of sufficient intensity to heat certain members of a steel headframe and tipple and thus cause a fire on the tipple. This is an isolated case, but such an origin may well be given thought before a fire is placed in the "cause undetermined" class. A prominent coal-mining engineer recently said that at least 90 per cent of the present-day "mysterious" fires in coal mines are of electrical origin.

Explosives occupy the third place on the list of ignition agents in mine fires. Long-flame explosives have caused hundreds of mine fires; but for the continued growth of the use of permissible explosives, long-flame explosives such as dynamite and black blasting powder would be first on the list.

In many districts where black blasting powder and dynamite are still used in coal mining, "fire runners" are employed to search for fires after shooting. These men are required to extinguish fires started by blasting with these explosives. This type of precautionary service is decidedly valuable. Where work has been intermittent, many such fires have reached serious proportions during the idle days; not only have they caused much trouble, but in some instances have also resulted in explosions. Explosives and fuse have also served as media to aid the relatively low heat of a glowing match stem or cigarette butt to start many large and serious fires.

To complete the "foreign heat ignitions" and act as a connecting link with "spontaneous ignitons," there are several important but rare causes of fires:

The frictional heat of machine bearings has caused fires which probably start in the oil and grease accumulations on the machine itself and spread to inflammable material in the vicinity. Pumps, underground fans, and similar machinery, which often run for long periods with little attention, are the most probable sources of fire from frictional heat. Rollers on rope haulage and friction of rope on timbers have caused fires; a recent serious metal-mine fire is ascribed to the latter cause.

Steam lines have been charged with starting mine fires; although the accuracy of this charge may be questioned, nevertheless the heat radiated by lines carrying steam and hot water would no doubt greatly assist in accelerating "spontaneous ignition" in coal dust, trash, oily clothes, or similar highly inflammable material that might be nearby.

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The causes of "spontaneous ignitions," -- the second main class of mine fires -- should be fully understood by the entire mining fraternity, even though this cause varies decidedly in frequency and seriousness among the various mining districts of the United States.

Any extraneous inflammable material that is known to fire spontaneously on the surface can be expected to fire spontaneously, under favorable conditions, when taken underground. Oily material and "trash" are especially likely to ignite spontaneously. Timber stored or in place is not commonly thought subject to spontaneous ignition, but care must be taken that such storage be kept free from even small amounts of finely divided bark, splintered wood, oily waste, or any material that could furnish a small point of firing whence the flame might spread quickly to large proportions. Spontaneous fires have occurred in accumulated piles of wood splinters or bark at the foot of timber slides in metal mines.

Sulphide ores, especially of copper and iron, are known to fire spontaneously when aided by the heat of crushing.

There are not enough data available to permit classification of any given coal as free from all possibility of spontaneous ignition under every condition. However, many coals are known to be prone to spontaneous combustion and require continuous vigilance, care, and even special mining methods to make their recovery possible with reasonable safety. Spontaneous fires are seldom accompanied by fatalities; the time required in the heating process usually gives opportunity for detection, so that steps to avoid fatalities can be taken. These fires, however, have cost much time, effort, and money and have taken a great toll in property and equipment.

Fires have sometimes gone underground, although started in surface buildings near shafts or other openings. Such fires are liable to occur at any time when head frames, tipples, hoist houses, and other constructions are not fireproof.

Fires in outcrops, some of untold years' standing, have been cut into and have spread through the active mine workings. Care should be exercised not to locate rock dumps, which are likely to burn, over outcrops; nor should rock dumps be located above mine areas that might cave to the surface and allow the hot dump material to reach the underground workings. It is recorded that a coal vein was completely burned at 1,800 feet from the outcrop and under several hundred feet of cover. If there is any indication of "crop" fire ever having occurred, careful study should be made to determine whether the fire might still be active, and the limits should be accurately mapped.

Veins of coal have been burned and coked by intrusive molten dykes. Few if any such fires have been found active, but there is no reason why it would not be possible to have heating conditions near underground dykes that might start fires.

To give examples of fires started by all the media discussed is not feasible in a paper of this kind, nor will an attempt be made to suggest all of the preventive measures that have been and should be used to reduce the opportunity for such occurrences. Most of the answers to the problems of fire prevention are self evident. However, it may be well for every operator to request of his organization a concrete and effective answer to the question "How to Prevent Fires in our Mines."

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